# COURSE CURRICULAM

*for*

# M.TECH. DEGREE

*in*

# MECHANICAL ENGINEERING

*(Applicable from the academic session 2024-2025)*

Approved by BOS(ME) dt 5.11.2024 &
Academic Council, Agenda-01.02, dt 21.11.2024

DR. B.C. ROY SOCIETY
ENGINEERING
AN AUTONOMOUS INSTITUTE

## Dr. B. C. Roy Engineering College

***An Autonomous Institution***

***Approved by: All India Council for Technical Education (AICTE)***

***Affiliated to: Maulana Abul Kalam Azad University of Technology, West Bengal***
***(Formerly Known as -WBUT)***

**Jemua Road, Durgapur, West Bengal, India,713206**

**Course Name: Advanced Machine Design**

**Course Code: MME -201**
**Semester-II**
**Category: Major**

**Course Broad Category: Mechanical Engineering**

1. **Course Prerequisite:**
   knowledge of Engineering Mechanics ,strength of materials and solid mechanics.
2. **Course Learning Objectives:**

a) a) Comprehend the concept of tribology for applying lubrication in bearings and other machine elements

b) Design the tribological systems consisting bearings

c) Apply mathematical concept in practical solid mechanics problems.

a) Understand the advanced concept of stress-strain behaviour of materials.

3. **Teaching methodology and evaluation system for the course:**
   **Teaching methodology** –Lectures and Presentations, Interactive Discussions and real world problem discussion.
   **Evaluation System –**
   Attendance
   Internal Assessment (20 Marks)- Formative Continuous Assessment [Continuous Assessment 1 (10 Marks); Continuous Assessment 2 (10 Marks)]
   Mid-Term Exam (30 Marks)- Summative Assessment
   End-Semester Exam (50 Marks)- Summative Assessment.

4. **Course Content:**
   **Course Name: Advanced Machine Design**
   **Course Code: MME 201**
   **Hours per Week: 3L:1T:0P**
   **Credits: 4**

5.

| Module | Topics | 42L | CO |
|---|---|---|---|
| 1. | Hydrodynamic Lubrication of Sliders and Bearings, Long and Short Bearings, Pressure distribution, Oil film thickness, Load carrying capacity, | 9L | CO1,CO2,CO3,CO4, |
| 2. | Friction and heating of journal bearing. | 5L | CO1,CO2,CO3,CO4 |

| Module | Topics | 42L | CO |
|---|---|---|---|
| 3. | Torsion of non circular shafts. | 10L | CO1,CO3,CO4 |
| 4. | Press fitted assemblies and rotating discs. | 6L | CO1,CO3,CO4,CO6 |
| 5. | Fatigue strength, Fluctuating loads, Cumulative fatigue damage. | 4L | CO1,CO3,CO4,CO5 |
| 6. | Contact stresses. | 4L | CO1,CO3,CO4 |
| 7. | Dynamic load on gears | 4L | CO1,CO3,CO4,CO5 |

## 6.Text Book:

1.Engineering Tibology,Prasanta Sahoo,PHI
2.Advanced Mechanics of Solids,L.S.Srinath
3.Introduction to Tribology , B. C. Majumder
4.Advanced Strength of Materials, Seely, Smith

## 7.Reference Books:

1.Analytical Mechanics for Gear, E. Buckingham
2.Analysis of Mechanical Design, A. Burr
3. Mechanical Design Analysis, M.F.Spoots
4. Mechanical Design Analysis. Arthur Burr
5. Theory Of Elasticity, Timoshenko & Goodyear, McGraw-Hill
6. Machine Design, Robert L. Norton
7. Practical Gear design - D.W. Dudley
8. Optimum design - R.C.Jhonson
9. Mechanical Springs – A.M. Wahl.
10. An introduction to composite materials – D. Hull and T.W. Clyne

## 8.Course Outcomes:

| Course Outcomes | Details/Statement | Action Verb | Knowledge Level |
|---|---|---|---|
| **CO1** | Students will be able to identify the significant loads on various Machine Components | Identyfy | Remember |
| **CO2** | Students will be able to apply knowledge of Lubrication methods and various design aspects of sliding contact bearings. | Apply | Apply |
| **CO3** | Students will learn to describe the stress in machine components having complicated shape | Describe | Understand |
| **CO4** | Students will be able to apply knowledge for designing machine components for given lifespan and also predict damage that can occur during its. | Apply | Apply |

| | | | |
|---|---|---|---|
| **CO5** | Students will be able to explain the functioning of gears and the concept of maximum load that can appear on such gears and methods to be adopted for improving the life of gears. | Explain | Understand |
| **CO6** | Students will be able to Analyze axisymmetric problems. | analyze | analyze |

**Course Name: ENGINEERING MECHANICS**
**Course Code: MME202**
**(Semester I)**
**Category: Major**

**Course Broad Category: Engineering Science Courses**

1. **Course Prerequisite:**
   Manufacturing Processes, Probability and Statistics

2. **Course Learning Objectives:**
   i. This course introduces production and operations management of enterprises.
   ii. The course aims to provide detail knowledge on MRP II and capacity planning.
   iii. The course also aims to provide scientific Approach to forecasting, inventory and human resources.
   iv. The course aims to provide sound understanding of quality, quality assurance and quality control.

3. **Teaching methodology and evaluation system for the course:**
   **Teaching methodology –**Lectures and Presentations, Interactive Discussions and real world problem discussion.
   **Evaluation System –**
   Attendance
   Internal Assessment (20 Marks)- Formative Continuous Assessment [Continuous Assessment 1 (10 Marks); Continuous Assessment 2 (10 Marks)]
   Mid-Term Exam (30 Marks)- Summative Assessment
   End-Semester Exam (50 Marks)- Summative Assessment.

4. **Course Content:**
   **Course Name:** Production And Operation Management
   **Course Code:** MME202
   **Hours per Week:** 4L:0T:0P
   **Credits:** 3

| Module | Topics | 42L | CO |
|---|---|---|---|
| 1. | Introduction to Production and Operation management: Basic management functions, Managerial skill. Concept of productivity and its analysis. | 7 | CO1 |
| 2. | Capacity planning, MRP II, Work measurement, facility layout and assembly line balancing, multiple criteria decision making methods, Line of Balance (LOB), Markov model | 8 | CO2 |
| 3. | Operation strategy: Forecasting for operation, Process and technologies, Inventory planning & control. | 10 | CO3, |

| Module | Topics | 42L | CO |
|---|---|---|---|
| | Material requirement planning, planning for production and operation scheduling. | | |
| 4. | HR in operation management- manpower planning, training & development, health, safety, welfare, remuneration & Incentive scheme. | 9 | CO4 |
| 5. | Quality Assurance – The quality assurance system, choice of process and reliability, control of quality. Quality aspect in production and services. | 11 | CO5 |

## 6. References:

**Text Book:**


1. Production and Operations Management – E. B Adam, Jr. and R. J. Ebert, Prentice Hall.
2. Modern Production/ Operations Management – Buffa and Sarin 8th ed. John Wiley & sons (Asia)
3. Advances in Production Management Systems – C. H. Okino, Narosa Book Distributors Pvt. Ltd.
4. Production and Operations Management – W. Bolton, Orient Longman Pub.
5. Production and Operations Management - Muhlemann, Oakland and Lockyer, Mcmillian India Lt
6. Operations Management – Russell and Taylor – Wiley India Pvt. Ltd.
7. Operation Management – B. Shore, EMH Publishing Co. Ltd. ,India.
8. Total Quality Management – A. Tenner and I. J. Detoro, Addison Wesley Publication.


## 7. Reference Books:


1. Management Information Systems, Prentice Hall , Larry Long
2. Enterprise Resource Planning, TMH, A.Leon
3. Human Resource Management, Sultan Chand & Sons., Gupta, C.B

4. Operations Management – B. Shore, EMH Publishing Co. Ltd., India
5. Management for Business and Industry – G.S. George, PHI Publication
6. Production and Operations Management - Concepts Mode1s and Behaviour - 5th Ed., Adam and Ebert, PHI Publication.
7. The Management of Engineering – J.W. Bennett, Narosa Book Distributors Pvt. Ltd.
8. Production and Operations Management - A W Muthelemann, Narosa Book Distributors Pvt. Ltd.


## 6. Course Outcomes:

| Course Outcomes | Details/Statement | Action Verb | Bloom's Level |
|---|---|---|---|
| CO1 | The students will be able to define production and operations management | Define | Remembering |
| CO2 | The students will be able to plan for capacity and materials requirements. | Plan | Creating |
| CO3 | The students will be able to assess the requirement | Assess | Evaluate |

| | | | |
|---|---|---|---|
| | of inventory. | | |
| **CO4** | The students will be able to understand human resource and its implications. | Understand | Understanding |
| **CO5** | The students will be able to assess and evaluate the quality standard and meet quality assurance. | Assess | Evaluating |

**Course Name: DESIGN OF MATERIALS HANDLING EQUIPMENT**
**Course Code:** MME 203A
**(Semester II)**
**Category: Major**

**Course Broad Category: Optional Elective Course**

1. **Course Prerequisite:**
   Basic knowledge of mechanical design and engineering concepts.

2. **Course Learning Objectives:**
   I. To classify materials and equipment used in material handling.
   II. To analyze and calculate the capacity and power requirements for various conveyors.
   III. To explore the principles and design of lifting equipment and cranes.
   IV. To understand the operation and selection of vibratory and pneumatic conveying systems.

3. **Teaching methodology and evaluation system for the course:**
   **Teaching methodology –** Lectures and Presentations, Interactive Discussions and real world problem discussion.
   **Evaluation System –**
   - Attendance
   - Internal Assessment (20 Marks)- Formative Continuous Assessment [Continuous Assessment 1 (10 Marks); Continuous Assessment 2 (10 Marks)]
   - Mid-Term Exam (30 Marks)- Summative Assessment
   - End-Semester Exam (50 Marks)- Summative Assessment.

4. **Course Content:**
   **Course Name:** Design of Materials Handling Equipment
   **Course Code:** MME 203A
   **Hours per Week:** 4L:0T:0P
   **Credits:** 4

| Module | Topics | 42L | CO |
|---|---|---|---|
| 1. | **Classification of Materials and Equipment:** Overview of materials handling, types and classifications of equipment. | 4L | CO1 |
| 2. | **Conveying Equipment:** Belt conveyors: Construction and layout. Belt selection and power calculation. Capacity and power calculation for bucket elevators. | 10L | CO2 |
| 3. | **Specialized Conveyors:** Apron, Scraper, and Screw conveyors. Roller and Chain-trolley conveyors. Pneumatic conveying. | 8L | CO3 |
| 4. | **Vibratory Conveyors and Lifting Equipment:** Principles of working and applications. Selection of ropes, chains, sheaves, and drums for | 8L | CO4 |

| Module | Topics | 42L | CO |
|---|---|---|---|
| | lifting equipment. | | |
| 5. | **Cranes:** Construction and power calculations of Electric overhead traveling cranes. Crane motors and brakes. | 8L | CO5 |
| 6. | **Grab operators:** Design and applications. | 4L | CO6 |

## 6. References:


1. Material Handling System Design Apple, J.M --, John Wiley & Sons
2. Materials Handling: Principles and Practice, Allegri,T.H., CBS Publishers & Distributors, N. Delhi
3. Materials Handling, Immer-, J.R, McGraw Hills
4. Conveyors and Related Equipment. Spivakovsky, A and Dyachkov, V-, Peace Publishers, Moscow
5. Materials Handling Equipment, Rudenko N.- Peace Publishers, Moscow
6. Materials Handling Equipment, Alexandrov, M.P Part-I and II, Mir Publishers, Moscow
7. Mechanical Handling of Materials, Ray, T.K.- Asian Books Private Ltd., 2004
8. Introduction to Materials Handling Ray, S.-, New Age International Publishers, 2008.
9. Aspects of Materials Handling, K.C. Aroraq, V.V. Shinde, Laxmi Publication
10. Conveying machine, vol. 2 – A. Spivakosky & V Dyachkov – MIR Publisher
11. Material Handling equipment – M. P. Alexandrov – MIR Publisher
12. Belt Conveyors for Bulk material - CEMA
13. Material Handling, John R. Immer, McGrawHill Co. Ltd., New York.
14. Material Handling in Machine Shops - Colin Hardi, Machinery Publication Co. Ltd., Landon.
15. Bulk Solid Handling -C. R. Cock and J. Mason, Leonard Hill Publication Co. Ltd., U.S.A.
16. Material Handling Hand Book- Kulwiac R. A., JohnWilly Publication, NewYork.
17. Material Handling Equipments -N. Rudenko, Peace Publishers, Moscow.
18. Material Handling System Design - James M. Apple, , John-Willlwy and Sons Publication, NewYork.
19. Material Handling Equipment -M .P. Nexandrn, MIR Publication, Moscow.
20. Conveying Machines -Spivakovsy, A.O. and Dyachkov, V.K., Volumes I and II, MIR Publishers, 1985. New York.


## 7. Course Outcomes:

| Course Outcomes | Details/Statement | Action Verb | Knowledge Level |
|---|---|---|---|
| **CO1** | Identify materials and equipment in material handling systems. | **Identify** | Understand |
| **CO2** | Calculate power and capacity requirements for conveying equipment. | Calculate | Apply |
| **CO3** | Illustrate principles and applications of specialized conveying systems. | Illustrate | Analyze |
| **CO4** | Recommend suitable design for vibratory conveyors and lifting equipments using appropriate components. | Recommend | Evaluate |
| **CO5** | Determine power requirements and operational characteristics for cranes. | Determine | Apply |
| **CO6** | Demonstrate design and applications of **grab operators.** | Demonstrate | Apply |

**Course Name: THEORY OF ELASTICITY AND PLASTICITY**
**Course Code: MME 203B**
**(Semester II)**
**Category: Major**

**Course Broad Category: Professional Elective**

1. **Course Prerequisite:**
   - Solid mechanics
   - Materials science
   - Mathematics (e.g. differential equations, linear algebra)

2. **Course Learning Objectives:**
   - To understand the fundamental principles of elasticity and plasticity
   - To learn how to apply the theory of elasticity to solve engineering problems
   - To understand the behavior of elastic and plastic materials
   - To develop skills in using mathematical models to analyze and design engineering systems

3. **Teaching methodology and evaluation system for the course:**
   **Teaching methodology –**Lectures and Presentations, Interactive Discussions and real world problem discussion.
   **Evaluation System –**
   Attendance,
   Internal Assessment (20 Marks)- (a) Formative Continuous Assessment [Continuous Assessment 1 (10 Marks); (b) Continuous Assessment 2 (10 Marks)]
   Mid-Term Exam (30 Marks)- Summative Assessment
   End-Semester Exam (70 Marks)- Summative Assessment.

4. **Course Content:**
   **Hours per Week:** 4L:0T:0P
   **Credits:** 4

| Module | Topics | 42L |
|---|---|---|
| 1 | Introduction to Elasticity<br>- Overview of elasticity and plasticity<br>- Introduction to stress, strain, and Hooke's law | 4L |
| 2 | Mathematical Formulation of Elasticity<br>- Equations of equilibrium and compatibility<br>- Stress-strain relationships and constitutive equations<br>- Boundary value problems and solutions | 8L |

| Module | Topics | 42L |
|---|---|---|
| 3 | Elasticity of Isotropic and Anisotropic Materials<br>- Elastic behavior of isotropic materials<br>- Elastic behavior of anisotropic materials<br>- Orthotropic and transversely isotropic materials | 8L |
| 4 | Plasticity and Yielding<br>- Introduction to plasticity and yielding<br>- Yield criteria and flow rules<br>- Hardening and softening behavior | 8L |
| 5 | Theory of Plasticity<br>- Mathematical formulation of plasticity<br>- Deformation theory and flow theory<br>- Application of plasticity theory to engineering problems | 8L |
| 6 | Fracture Mechanics and Failure<br>- Introduction to fracture mechanics<br>- Stress intensity factors and fracture toughness<br>- Failure criteria and design considerations | 4L |
| 7 | Case Studies and Projects<br>- Real-world case studies of elasticity and plasticity applications<br>- Group projects to analyze and design engineering systems using elasticity and plasticity principles | 8L |

## 6. Reference Books:


1. Theory of Elasticity & Plasticity, Timoshenko Young
2. Strength of Material, Vol-II, Timoshenko
3. Theory of Plates and Shells- Timoshenko
4. "Theory of Elasticity" by S. Timoshenko and J. N. Goodier
5. "Elasticity: Theory, Applications, and Numerics" by M. E. Gurtin
6. "Plasticity: Theory, Applications, and Numerics" by J. Lubliner
7. "Theory of Plasticity" by J. Betten
8. "Elasticity and Plasticity" by A. Mendelson

## 7. Course Outcomes:

| Course Outcomes | Details/Statement | Action Verb | Knowledge Level |
|---|---|---|---|
| **CO1** | Understand the fundamental principles of elasticity and plasticity | understand | understand |
| **CO2** | Analyze and design engineering systems using elasticity and plasticity principles | analyze | analyze |
| **CO3** | Apply the theory of elasticity to solve engineering problems | Apply | Apply |
| **CO4** | Understand the behavior of elastic and plastic materials | understand | understand |
| **CO5** | Develop skills in using mathematical models to analyze and design engineering systems | analyze | analyze |
| **CO6** | Communicate effectively the results of elasticity and plasticity analysis and design | communicate | understand |

**Course Name: DESIGN AND PERFORMANCE OF MACHINE TOOLS**
**Course Code: MME 203C**
**(Semester II)**
**Category: Major**

**Course Broad Category: Professional Elective**

1. **Course Prerequisite:**
   - Mechanical engineering or related field
   - Mathematics (e.g. calculus, linear algebra)
   - Physics (e.g. mechanics, thermodynamics)

2. **Course Learning Objectives:**
   - To understand the principles of machine tool design
   - To learn how to select machine tool components
   - To evaluate the performance of machine tools
   - To design and develop machine tools for specific applications
   - To understand the importance of machine tool design and performance in manufacturing

3. **Teaching methodology and evaluation system for the course:**
   **Teaching methodology –**Lectures and Presentations, Interactive Discussions and real world problem discussion.
   **Evaluation System –**
   Attendance,
   Internal Assessment (20 Marks)- (a) Formative Continuous Assessment [Continuous Assessment 1 (10 Marks); (b) Continuous Assessment 2 (10 Marks)]
   Mid-Term Exam (30 Marks)- Summative Assessment
   End-Semester Exam (70 Marks)- Summative Assessment.

4. **Course Content:**
   **Hours per Week:** 4L:0T:0P
   **Credits:** 4

| Module | Topics | 42L |
|---|---|---|
| 1 | Introduction to Machine Tools<br>- Overview of machine tools and their importance in manufacturing<br>- Types of machine tools (e.g. lathes, milling machines, drilling machines) | 4L |
| 2 | Principles of Machine Tool Design<br>- Design considerations for machine tools (e.g. stiffness, damping, vibration) | 10L |

| Module | Topics | 42L |
|---|---|---|
| | - Selection of machine tool components (e.g. bearings, gears, motors)<br>- Design of machine tool structures (e.g. frames, columns, tables) | |
| 3 | Machine Tool Components<br>- Bearings and bearing selection<br>- Gears and gear selection<br>- Motors and motor selection<br>- Other machine tool components (e.g. spindles, chucks, tool holders) | 10L |
| 4 | Machine Tool Performance Evaluation<br>- Methods for evaluating machine tool performance (e.g. cutting tests, vibration tests)<br>- Factors affecting machine tool performance (e.g. tool wear, coolant, lubrication)<br>- Optimization of machine tool performance | 10L |
| 5 | Design of Machine Tools for Specific Applications<br>- Design of machine tools for specific manufacturing processes (e.g. turning, milling, grinding)<br>- Design of machine tools for specific materials (e.g. metals, plastics, composites)<br>- Design of machine tools for specific industries (e.g. aerospace, automotive, medical) | 10L |
| 6 | Case Studies and Projects<br>- Real-world case studies of machine tool design and performance<br>- Group projects to design and develop machine tools for specific applications | 6L |

**6. Reference Books:**


1. Metal Cutting Principles, Milton C. Shaw- Oxford University Press
2. Machine Tools Design, N.K.Meheta - Tata McGraw -Hill Publishing.
3. Principles of Metal Cutting G.Kuppuswamy -, Universities Press
4. Design of Machine Tools Oxford S.K.Basu&D.K. Pal- & IBH Publishing Co.
5. Machine Tool Design Edited by N.Acherkan- : 4 vols, Mir Publishers, Moscow
6. Metal Cutting Theory and PracticA.Bhattacharya- e, New Central Book Agency (P) Ltd.
7. Computer Control of Manufacturing Systems by Y. Koren, McGraw-Hill

8. Numerical Control and Computer Aided manufacturing by R. S. Pressman & J. E. Williams, John Wiley & Sons
9. Computational Geometry for Design and Manufacture, by I. D. Faux and M. J. Pratt, Ellis Horwood, Chichester, 1979.
10. Numerical Control in Manufacturing by F. W. Wilson, McGraw-Hill Book Company New York
11. Principles of Machine Tools - G.C. Sen and A. Bhattacharya
12. Machine Tool Design, N.K. Mehta, TMG Publications,
13. Fluid Power Control - J.F. Blackburn, G. Reetholf and J.L. Shearer, New York Technology Press of MIT and Wiley
14. Oil Hydraulic Power and Its Industrial Applications - W. Ernst, 2nd Ed. New York, McGraw Hill
15. Hydraulic Control Systems - H.E. Merrit
16. Testing of Machine Tools - G. Shleisinger, Pergamon Press
17. Elements of Vibration Analysis - L. Meirovitch, McGraw Hill Co.
18. Mechatronics - W. Bolton, Addition Wesley Longman, Singapore.
19. Mechatronics - HMT Limited, Tata McGraw Hill
20. Precision Engineering in Manufacturing - R. L. Murty, New Age International Publishers.
21. Ergonomics and Work Design - P.K. Nag, New Age Int. Publishers
22. Mechanical Vibration - M.P. Groover, PHI Publication.

**23. Course Outcomes:**

| Course Outcomes | Details/Statement | Action Verb | Knowledge Level |
|---|---|---|---|
| CO1 | Understand the principles of machine tool design | understand | understand |
| CO2 | Select machine tool components | select | analyze |
| CO3 | Evaluate the performance of machine tools | evaluate | Apply |
| CO4 | Design and develop machine tools for specific applications | design | evaluate |
| CO5 | Optimize machine tool performance | optmize | analyze |
| CO6 | Communicate effectively the results of machine tool design and performance | communicate | understand |

**Course Name: ADVANCED WELDING TECHNOLOGY**
**Course Code: MME 203D**
**(Semester II)**
**Category: Major**

**Course Broad Category: Professional Elective**

1. **Course Prerequisite:**
   - Welding fundamentals and safety
   - Metallurgy and materials science
   - Mathematics (e.g. algebra, geometry)

2. **Course Learning Objectives:**
   - To understand the principles of advanced welding technologies
   - To learn about the latest developments in welding technology
   - To apply advanced welding technologies to real-world problems
   - To develop skills in welding process selection, weldability evaluation, and welding metallurgy
   - To understand the importance of safety, quality, and productivity in welding operations

3. **Teaching methodology and evaluation system for the course:**
   **Teaching methodology –**Lectures and Presentations, Interactive Discussions and real world problem discussion.
   **Evaluation System –**
   Attendance,
   Internal Assessment (20 Marks)- (a) Formative Continuous Assessment [Continuous Assessment 1 (10 Marks); (b) Continuous Assessment 2 (10 Marks)]
   Mid-Term Exam (30 Marks)- Summative Assessment
   End-Semester Exam (70 Marks)- Summative Assessment.

4. **Course Content:**
   **Hours per Week:** 4L:0T:0P
   **Credits:** 4

| Module | Topics | 42L |
|---|---|---|
| 1 | Introduction to Advanced Welding Technology<br>- Overview of advanced welding technologies<br>- History and development of welding technology | 4L |
| 2 | Welding Processes<br>- Shielded Metal Arc Welding (SMAW)<br>- Gas Metal Arc Welding (GMAW) | 10L |

| Module | Topics | 42L |
|---|---|---|
| | - Gas Tungsten Arc Welding (GTAW)<br>- Flux Cored Arc Welding (FCAW)<br>- Submerged Arc Welding (SAW) | |
| 3 | Weldability and Welding Metallurgy<br>- Weldability of metals and alloys<br>- Welding metallurgy and microstructure<br>- Phase transformations and weld microstructure<br>- Welding defects and imperfections | 10L |
| 4 | Advanced Welding Techniques<br>- Pulse welding and pulse welding techniques<br>- Narrow gap welding and narrow gap welding techniques<br>- Orbital welding and orbital welding techniques<br>- Laser welding and laser welding techniques | 10L |
| 5 | Welding Automation and Robotics<br>- Introduction to welding automation and robotics<br>- Welding automation systems and components<br>- Robotics and robotic welding systems<br>- Programming and operation of welding automation and robotics systems | 10L |
| 6 | Welding Safety, Quality, and Productivity<br>- Welding safety and hazards<br>- Welding quality and quality control<br>- Welding productivity and efficiency<br>- Welding cost estimation and cost control<br>Case Studies and Projects<br>- Real-world case studies of advanced welding technology applications<br>- Group projects to design and develop welding processes and systems | 6L |

## 6. Reference Books:


1. Basic Fabrication & Welding, Kenyon PitmanPitman Pub. Ltd.
2. Basic Fabrication & Welding, F.J.M. Smith- Longman Group Ltd.
3. Workshop Technology Vol. 1 & 2, Hazra & Choudhuri- Media Promoters & Publications
4. Welding Technology O.P. Khanna-, Dhanpat Rai & Sons
5. Manufacturing Technology P.N.Rao-, Tata McGraw Hill
6. Materials & Processes in Manufacturing DE Garmo et al-– Wiley
7. Introduction to the Theory of Theoretical and Experimental Analysis of Stress and Strain" - Durelli, Phillip's and Tsao, McGraw Hill Book Co.
8. Theory of Elasticity - Timoshenko and Goodier, McGraw Hill Book Co.
9. Engineering Plasticity - Johnson and Mellur, Van Nostrand-Reinhold Co.
10. Introduction to the Theory of Plasticity - Metal Forming Applications" - O. Hoffman and G. Sachs, McGraw Hill Book Co.
11. Introduction to Theory of Plasticity - Mendelson.
12. Principles of Metal Casting - Heine, Loper and Rosenthal, TMH Publication
13. Principles of Foundry Technology - P.L. Jail, TMH Publications
14. Welding for Engineers - Udin, Funk and Wulf, John Wiley and Sons.
15. Welding Process and Procedures - J.L. Morris.
16. A Text Book of Welding Technology - O.P. Khanna, Dhanpat Rai & Sons
17. Modern Arc Welding Technology - S.V. Nadkarni, Oxford & IBH Publishing Co. Pvt. Ltd./ Advani-Oerlikon Ltd.
18. Processes and Design for Manufacturing - S.D.El Wakil, PWS Publishing.


## 7. Course Outcomes:

| Course Outcomes | Details/Statement | Action Verb | Knowledge Level |
|---|---|---|---|
| CO1 | Understand the principles of advanced welding technologies | understand | understand |
| CO2 | Apply advanced welding technologies to real-world problems | apply | Apply |
| CO3 | Develop skills in welding process selection, weldability evaluation, and welding metallurgy | Develop | Apply |
| CO4 | Understand the importance of safety, quality, and productivity in welding operations | understand | understand |
| CO5 | Design and develop welding processes and systems | design | analyze |
| CO6 | Demonstrate effectively the results of welding technology applications | demonstrate | understand |

**Program: M.Tech in Mechanical Engineering**
**Course Name: ADVANCED ROBOTICS**
**Course Code: MME204A**
**(Semester II)**
**Category: Minor**

**Course Broad Category: (Prof.) Elective-IV**

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1. **Course Prerequisite:**
   Knowledge of Engineering Mechanics, Mathematics (Matrices and Coordinate Geometry, Differential and Integral Calculus), Theory of Machines

2. **Course Learning Objectives:**

   1. Understand advanced robotic concepts: Analyze and explain advanced robotic concepts, including robot kinematics, dynamics, and control.
   2. Robot sensing and perception: Understand various robotic sensing and perception techniques, including computer vision, sensor fusion, and machine learning.
   3. Robot motion planning and control: Apply advanced motion planning and control techniques to enable robots to navigate and interact with complex environments.

3. **Teaching methodology and evaluation system for the course:**
   **Teaching methodology –**Lectures and Presentations, Interactive Discussions and real world problem discussion.
   **Evaluation System –**
   Attendance
   Internal Assessment (20 Marks)- Formative Continuous Assessment [Continuous Assessment 1 (10 Marks); Continuous Assessment 2 (10 Marks)]
   Mid-Term Exam (30 Marks)- Summative Assessment
   End-Semester Exam (50 Marks)- Summative Assessment.

4. **Course Content:**
   **Course Name: Advanced Robotics**
   **Course Code: M**ME101
   **Hours per Week:** 4L:0T:0P
   **Credits:** 4

| Module | Topics covered | Mapped with CO | L |
|---|---|---|---|
| 1 | Syllabus, Books, Introduction, History of robots | CO1 | 2L |
| | Definition of robot; Anatomy of robot, Classification | CO1 | 2L |
| | Robot geometry: types of joints, workspace, number of degrees of freedom; Common configurations used in arms: rectangular, cylindrical, spherical, | CO1 | 2L |

| | | | |
|---|---|---|---|
| | joined | | |
| | Robot specifications: payload, accuracy, repeatability resolution, maximum tip speed, reach stroke. 3 Problems solved | CO1 | 2L |
| 2 | Robot Actuators-Electrical, Hydraulic, Pneumatic, Special type | CO2 | 2L |
| | Kinematics of Manipulator-Forword & Inverse kinematics, Kinematic diagram, Spatial description & Frame transformation; | CO2 | 2L |
| | Translational & Rotational operators; their Application; Link & Joint parameters, D-H convention | CO2 | 2L |
| | Application of DH convention --3DOF planar manipulator - Forward & Inverse kinematics | CO2 | 2L |
| | Jacobians: Position and linear velocity; Angular velocity - graphical and mathematical approaches; Motion of Robot Links; Velocity propagation from link to link; Problem(example) | CO2 | 2L |
| | Jacobians, Changing a Jacobian's frame of reference, Jacobian Inverse; Singularities, Classification, Problem(example). | CO2 | 2L |
| | Use Jacobian control with intermediate positions to determine the successive angular positions of the joints. | CO2 | |
| | Static Forces in Manipulator, Jacobian in Static Force domain, Problem(example) | CO2 | |
| 3 | Planning of manipulator trajectories, Path vs. Trajectory, Joint space schemes, Cartesian space schemes; Cubic polynomial, Fifth order polynomial, Linear with parabolic blends | CO3 | |
| 4 | Robot End Effector : Definition, gripper, tools; Gripper : main parts, source of power; Types of grippers: mechanical grippers, Vacuum cups, magnetic grippers, | CO4 | 2L |
| | Peg-in-hole problem, Passive gripper, Remote center compliance | CO4 | 2L |
| | Robot Sensors: Definition; Sensor vs. transducer; Functions, Characteristics; Calibration; Basic categories of measuring devices: analog, discrete; Placement of sensor | CO4 | 2L |
| | Main types of sensors: position-Encoders-Absolute & incremental | CO4 | 2L |
| | Potentiometers, force & torque Sensors, LVDT, RVDT | CO4 | 2L |
| | Range sensor, velocity, acceleration, Proximity sensors-inductive, Hall effect, capacitive | CO4 | 2L |
| | Robot Vision System: definition, use, functions, components, classification; vision cameras | CO4 | 2L |
| 5 | Robot programming - online method, Manual & Lead through teaching | CO5 | 2L |
| | Robot programming - offline method, Bottom-up programming, Language - VAL, MCL; Robot Programming (Contd.) -Other languages, Robot programing commands, Example-Pick and Place operation | CO5 | |
| 6 | Economics of Robots ; Previous yrs Q.P. discussion | CO6 | 2L |
| | | | 44L |

## 6. References:


1. **Introduction to Robotics by J.J.Craig, Pearson Education**
2. Robotic Engineering, Prentice-Klafter, Richard D. Chmielewaski, Thomas A. and Negin, Michael - Prentice Hall of India Pvt. Limited.

3. Industrial Robotics : Technology Programming and Applications, Groover, Mikell P. Weiss, Mitchell., Nagel, Roger N., Odrey, Nicholas G. - McGraw-Hill International Edition
4. Introduction to Robotics Analysis, Systems, Applications,-Niku, Saeed B. - Prentice Hall of India Private Limited, New Delhi
5. Fundamentals of Robotics: Analysis & Control, -Shilling , Robert J.- Prentice Hall of India, New Delhi
6. Robotics for Engineers-Koren, Yoram , McGrew-Hill Book Company, Sinagapore
7. Robotics: A User-Friendly Introduction, Hall, Ernest L. Hall Bettie C. - Holt, Rinehart and Winston, Holt-Saunders, Japan
8. Foundations of Robotics: Analysis and Control, Yoshikawa, Tsuneo Prentice Hall of India Private Limited, New Delhi
9. Mechanics of Robotic Manipulation, Mason, Matthew T. , Prentice Hall of India Private Limited, New Delhi.
10. **Robotics Technology and Flexible Automation , S.R.Deb, Tata Mc Graw Hill**
11. Industrial Robotics (Technology, Programming and applications), M.P.Groover, M. Weiss R.N. Nagel, N.G. Odrey McGraw, Hill
12. Robotics : Control, sensors, vision and intelligence - K.S.Fu, R.C.Gonzalez and C.S.G.Lee, - MCGraw-Hill.
13. Robotics Engineering, Klafter , Richard D., et al PhI.
14. Robotics & Control, Nagrath, TMH
15. Theory and Application of Robots, Chandan Chattoraj, Lambert Publishers, 2019

## 7. Course Outcomes:

| Course Outcomes | Details/Statement | Action Verb | Knowledge Level |
|---|---|---|---|
| CO1 | Demonstrate Robotic Anatomy and Illustrating industrial applications of Robots. | Demonstrate | Understand |
| CO2 | Analyse Kinematics of Robotic manipulators and actuators. | Analyse | Analyze |
| CO3 | Design Planning of manipulator trajectories using polynomials (upto $5^{th}$ order) | Design | Apply |
| CO4 | Demonstrate Robotic Sensors (tactile & non-tactile) and Robotic End Effectors. | Demonstrate | Evaluate |
| CO5 | Comprehend offline & online Robot Programming and write program blocks using VAL-II for pick-and-place movements. | Comprehend | Apply |
| CO6 | Analyze economics of robotics based on payback period & rate of return on investment. | Analyze | Analyze |

**Course Name: ENGINEERING FRACTURE MECHANICS**
**Course Code: MME204B**
**(Semester II)**
**Category: Major**

**Course Broad Category: Engineering Science Courses**

1. **Course Prerequisite:**
   Mechanics of Materials, Strength of Materials, or equivalent
2. **Course Learning Objectives:**
   1. Understand the fundamental principles of fracture mechanics
   2. Analyze and predict the fracture behavior of engineering materials and structures
   3. Apply fracture mechanics concepts to design and optimize engineering components
   4. Evaluate the fracture risk and reliability of engineering systems
3. **Teaching methodology and evaluation system for the course:**
   **Teaching methodology –**Lectures and Presentations, Interactive Discussions and real world problem discussion.
   **Evaluation System –**
   Attendance
   Internal Assessment (20 Marks)- Formative Continuous Assessment [Continuous Assessment 1 (10 Marks); Continuous Assessment 2 (10 Marks)]
   Mid-Term Exam (30 Marks)- Summative Assessment
   End-Semester Exam (50 Marks)- Summative Assessment.

4. **Course Content:**
   **Course Name:** Engineering Fracture Mechanics
   **Course Code:** MME204B
   **Hours per Week:** 4L:0T:0P
   **Credits:** 3

| Module | Topics | 42L | CO |
|---|---|---|---|
| 1 | Definition and importance of fracture mechanics. Historical development of fracture mechanics. Basic concepts: stress, strain, and fracture. Types of fractures: brittle, ductile, and mixed-mode. | 6 | CO1 |
| 2 | Linear elastic stress analysis. Stress concentrations and singularities. Energy principles and energy release rate. Stress intensity factors and fracture toughness. | 8 | CO2, CO3 |
| 3 | Griffith's criterion for brittle fracture. Irwin's criterion for ductile fracture. Mixed-mode fracture criteria. Fracture toughness testing and evaluation. Standard test methods (e.g., ASTM E399). Fracture toughness parameters (e.g., KIC, JIC). Limitations and uncertainties in fracture toughness testing. Statistical analysis of fracture. .toughness data. | 14 | CO4, CO5 |
| 4 | Failure assessment diagrams (FADs). R6 method for failure assessment. API 579 method for fitness-for-service assessment. Case studies of engineering failures. Fracture mechanics in | 14 | CO4, CO6 |

| | | | |
|---|---|---|---|
| | design and optimization. Emerging applications (e.g., nanomaterials, biomaterials). Fracture risk and reliability assessment. Case studies of successful applications | | |

## 6. References:

### Text Book:


1. Anderson, T. L. (2005). Fracture Mechanics: Fundamentals and Applications. CRC Press.

2. Broek, D. (1986). Elementary Engineering Fracture Mechanics. Springer.

3. Kanninen, M. F., & Popelar, C. H. (1985). Advanced Fracture Mechanics. Oxford University Press.


Additional Resources

1. Online lecture notes and slides

2. Video tutorials and animations

3. Fracture mechanics software and tools (e.g., ABAQUS, ANSYS)

## 7. Course Outcomes:

| Course Outcomes | Details/Statement | Action Verb | Bloom's Level |
|---|---|---|---|
| **CO1** | Understanding of fundamental concept. | Understand | R,U |
| **CO2** | Evaluate fracture risk | Evaluate | E |
| **CO3** | Apply fracture mechanics principles | Apply | P |
| **CO4** | Interpret fracture data | Interpret | U |
| **CO5** | Design for fracture resistance | Design | C |
| **CO6** | Analysis of fracture results | Analyze | A |

**Course Name: FINITE ELEMENT METHODS IN ENGINEERING**
**Course Code: MME204C**
**(Semester II)**
**Category: Major**

**Course Broad Category: Engineering Science Courses**

1. **Course Prerequisite:**
   Mechanics of Materials, Mathematics (Calculus, Linear Algebra), Programming skills (e.g., MATLAB, Python)
2. **Course Learning Objectives:**
   1. Understand the fundamental concepts of the Finite Element Method (FEM)
   2. Apply FEM to solve engineering problems in various fields (e.g., structural analysis, heat transfer, fluid dynamics)
   3. Use commercial FEM software (e.g., ANSYS, ABAQUS) to model and analyze engineering problems
   4. Develop programming skills to implement FEM algorithms
3. **Teaching methodology and evaluation system for the course:**
   **Teaching methodology –**Lectures and Presentations, Interactive Discussions and real world problem discussion.
   **Evaluation System –**
   Attendance
   Internal Assessment (20 Marks)- Formative Continuous Assessment [Continuous Assessment 1 (10 Marks); Continuous Assessment 2 (10 Marks)]
   Mid-Term Exam (30 Marks)- Summative Assessment
   End-Semester Exam (50 Marks)- Summative Assessment.
4. **Course Content:**
   **Course Name:** FINITE ELEMENTS METHOD IN ENGINEERING
   **Course Code:** MME204C
   **Hours per Week:** 4L:0T:0P
   **Credits:** 3

| Module | Topics | 42L | CO |
|---|---|---|---|
| 1 | Introduction to FEM. Overview of FEM. Historical development of FEM. Basic concepts: nodes, elements, meshing. Advantages and limitations of FEM. | 5 | |
| 2 | Weak form of the governing equation. Galerkin's method. Weighted residual method. Finite element formulation for 1D problems. Finite element formulation for 2D/3D structural analysis. Truss, beam, and frame elements. Plate and shell elements. Structural analysis using FEM software. | | |
| 3 | Finite element formulation for heat transfer problems. Finite element formulation for fluid dynamics problems. Heat transfer and fluid dynamics analysis using FEM software. | | |
| 4 | Nonlinear analysis (e.g., plasticity, contact). Dynamic analysis (e.g., vibration, wave propagation). Multiphysics analysis (e.g., thermo-mechanical, fluid-structure interaction). FEM to a real-world engineering problem | | |

## 6. References:

### Text Book:

1. Zienkiewicz, O. C., & Taylor, R. L. (2000). The Finite Element Method (5th ed.). Butterworth-Heinemann.

2. Reddy, J. N. (2006). An Introduction to the Finite Element Method (3rd ed.). McGraw-Hill.

3. Fish, J., & Belytschko, T. (2007). A First Course in Finite Elements. Wiley.

Software:

1. ANSYS

2. MATLAB

3. Python

## 7. Course Outcomes:

| Course Outcomes | Details/Statement | Action Verb | Bloom's Level |
|---|---|---|---|
| **CO1** | Explain basic concept of finite element methods | Explain | R,U |
| **CO2** | Evaluate finite element models | Evaluate | E |
| **CO3** | Analyze and interpret finite element results | Analyze | A |
| **CO4** | Apply FEM to real-world engineering applications | Apply | P |
| **CO5** | Develop programming skills for FEM | Develop | C |
| **CO6** | Formulate and solve engineering problems using FEM | Formulate | C |

**Course Name: COMPOSITE MATERIAL & STRUCTURE**
**Course Code: MME204D**
**(Semester II)**
**Category: Major**

**Course Broad Category: Engineering Science Courses**

1. **Course Prerequisite:**
   Mechanics of Materials, Strength of Materials, or equivalent.
2. **Course Learning Objectives:**
   1. Understand the fundamental principles of composite materials and structures.
   2. Analyze and design composite materials and structures for various engineering applications.
   3. Evaluate the mechanical behavior and properties of composite materials.
   4. Apply experimental and numerical methods to characterize and analyze composite materials and structures.
3. **Teaching methodology and evaluation system for the course:**
   **Teaching methodology –**Lectures and Presentations, Interactive Discussions and real world problem discussion.
   **Evaluation System –**
   Attendance
   Internal Assessment (20 Marks)- Formative Continuous Assessment [Continuous Assessment 1 (10 Marks); Continuous Assessment 2 (10 Marks)]
   Mid-Term Exam (30 Marks)- Summative Assessment
   End-Semester Exam (50 Marks)- Summative Assessment.
4. **Course Content:**
   **Course Name:** COMPOSITE MATERIAL AND STRUCTURE
   **Course Code:** MME204D
   **Hours per Week:** 4L:0T:0P
   **Credits:** 3

| Module | Topics | 42L | CO |
|---|---|---|---|
| 1 | Overview of composite materials. Classification of composite materials. Advantages and limitations of composite materials. Historical development of composite materials. | 6 | CO1 |
| 2 | Elastic behavior of composite materials. Stress-strain relationships for composite materials. Failure theories for composite materials. Mechanical properties of composite materials. Analysis of composite laminates. Design of composite structures for various loading conditions. | 12 | CO2,CO4 |
| 3 | Optimization of composite structures. Case studies of composite structures in engineering applications. Overview of composite manufacturing processes. Testing and characterization of composite materials. Experimental methods for evaluating composite material properties. Quality control and inspection of composite materials. | 14 | CO3,CO5 |

| | | | |
|---|---|---|---|
| 4 | Smart composite materials and structures. Nanocomposite materials and structures. Biocomposite materials and structures. Sustainable composite materials and structures. Design and analyze a composite material or structure for a real-world engineering application. | 10 | CO3,CO6 |

## 6. References:

### Text Book:


1. Agarwal, B. D., & Broutman, L. J. (1990). Analysis and Performance of Fiber Composites. John Wiley & Sons.

2. Jones, R. M. (1999). Mechanics of Composite Materials. Taylor & Francis.

3. Kaw, A. K. (2006). Mechanics of Composite Materials. CRC Press.


Software

1. ANSYS Composite PrepPost

2. MATLAB

3. Python

## 7. Course Outcomes:

| Course Outcomes | Details/Statement | Action Verb | Bloom's Level |
|---|---|---|---|
| **CO1** | Describe basic concept of Composite Materials. | Describe | R,U |
| **CO2** | Analyze composite materials and structures. | Analyze | A |
| **CO3** | Design composite materials and structures. | Design | C |
| **CO4** | Evaluate mechanical properties of composites. | Evaluate | E |
| **CO5** | Select composite materials for engineering applications. | Select | E |
| **CO6** | Apply manufacturing and testing methods for composites. | Apply | P |

**Course Name: Advanced Metrology**
**Course Code: MME 205A**
**(Semester II)**
**Category:**

**Course Broad Category:**

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1. **Course Prerequisite:**
   Basic Metrology
2. **Course Learning Objectives:**
   I. Inspection of engineering parts with various precision instruments.
   II. Design of part, tolerances and fits.
   III. Principles of measuring instruments and gauges and their uses.
   IV. Evaluation and inspection of surface roughness.
   V. Inspection of spur gear and thread elements.
   VI. Machine tool testing to evaluate machine tool quality.
3. **Teaching methodology and evaluation system for the course:**
   **Teaching methodology –** Lectures and Presentations, Interactive Discussions and real world problem discussion.
   **Evaluation System –**
   Attendance
   Internal Assessment (20 Marks)- Formative Continuous Assessment [Continuous Assessment 1 (10 Marks); Continuous Assessment 2 (10 Marks)]
   Mid-Term Exam (30 Marks)- Summative Assessment
   End-Semester Exam (50 Marks)- Summative Assessment.

4. **Course Content:**
   **Course Name:** Advanced Metrology
   **Course Code:** MME 205A
   **Hours per Week:** 3L: 0T:0P
   **Credits:** 3

| Module | Topics | 42L | CO |
|---|---|---|---|
| 1. | Generalised measurement system- Accuracy, Precision and errors. Indian system of limits and fits, Limit gauging. Screw thread tolerances. | 10L | CO1 and CO2 |
| 2. | Dimension chain. Statistical tolerancing. Error of flatness and surface texture. | 10L | CO2, CO5 and CO6 |
| 3. | Screw thread and gear metrology. Linear and angular measurements. Electrical transducers and their principles. | 10L | CO2 and CO4 |
| 4. | Comparators- Principles and use. Alignment test of machine tools. | 10L | CO6 |

| Module | Topics | 42L | CO |
|---|---|---|---|
| | | | |

## 6. References:

### Text Book:

1. Mechanical Measurement and Instrumentation. R. K. Rajput, Published by S. K. Kataria & Sons.
2. Engineering Metrology , R.K. Jain, Published by Khanna Publisher.

### Reference Books:

1. Mechanical Measurement and Instrumentation. R. K. Rajput, Published by S. K. Kataria & Sons.
2. Engineering Metrology , R.K. Jain, Published by Khanna Publisher.

## 7. Course Outcomes:

| Course Outcomes | Details/Statement | Action Verb | Knowledge Level |
|---|---|---|---|
| CO1 | **Apply** knowledge of various tools and techniques used to determine geometry and dimensions of components in engineering applications and used quality tools to produce quality product | Apply | Apply |
| CO2 | **Apply** knowledge of Inspection of spur gear and thread elements. | Apply | Apply |
| CO3 | **Develop** the ability to design of part, tolerances and fits. | Develop | Apply |
| CO4 | **Understand** principles of measuring instruments and gauges and their uses. | Understand | Evaluate |
| CO5 | **Develop** the ability for evaluation and inspection of surface roughness. | Develop | Apply |
| CO6 | **Apply** knowledge of Inspection of Engineering parts with various precision instruments. | Apply | Apply |

**Course Name: VALUES & ETHICS IN INDUSTRIAL MANAGEMENT**
**Course Code: MME205B**
**(Semester II)**
**Category: Major**

**Course Broad Category: Engineering Science Courses**

1. **Course Prerequisite:**
   Industrial Management
2. **Course Learning Objectives:**
   1. Understand the importance of values and ethics in industrial management.
   2. Identify and analyze ethical dilemmas in industrial management.
   3. Develop decision-making skills that incorporate ethical considerations.
   4. Apply values and ethics principles to real-world industrial management scenarios.
3. **Teaching methodology and evaluation system for the course:**
   **Teaching methodology –**Lectures and Presentations, Interactive Discussions and real world problem discussion.
   **Evaluation System –**
   Attendance
   Internal Assessment (20 Marks)- Formative Continuous Assessment [Continuous Assessment 1 (10 Marks); Continuous Assessment 2 (10 Marks)]
   Mid-Term Exam (30 Marks)- Summative Assessment
   End-Semester Exam (50 Marks)- Summative Assessment.

4. **Course Content:**
   **Course Name:** VALUES & ETHICS IN INDUSTRIAL MANAGEMENT
   **Course Code:** MME205B
   **Hours per Week:** 4L:0T:0P
   **Credits:** 3

| Module | Topics | 42L | CO |
|---|---|---|---|
| 1 | Overview of values and ethics in industrial management. Importance of ethics in business and industry. Ethical theories and principles (e.g., utilitarianism, deontology). Case studies of ethical dilemmas in industry. | 8 | CO1,CO2 |
| 2 | Decision-making models and frameworks. Ethical decision-making tools and techniques. Case studies of ethical decision-making in industry. Values and ethics in leadership and management. Corporate social responsibility and sustainability. Ethics in supply chain management and logistics. Case studies of values and ethics in industrial management. | 12 | CO2,CO3 |
| 3 | Effective communication in industrial management. Conflict resolution strategies and techniques. Negotiation and mediation in industrial management. Case studies of communication and conflict resolution in industry. | 12 | CO5,CO6 |

| | | | |
|---|---|---|---|
| 4 | Ethics in technology and innovation (e.g., AI, robotics). Sustainability and environmental ethics in industry. Diversity, equity, and inclusion in industrial management. Case studies of emerging issues in values and ethics. Apply values and ethics principles to a real-world industrial management scenario. | 10 | CO4,CO6 |

## 6. References:

### Text Book:


1. Bowie, N. E. (2017). Business Ethics: A Kantian Perspective. Cambridge University Press.

2. Crane, A., & Matten, D. (2016). Business Ethics: Managing Corporate Citizenship and Sustainability in the Age of Globalization. Oxford University Press.

3. Hartman, L. P. (2013). Business Ethics: Decision-Making for Personal and Professional Success. McGraw-Hill.


Additional Resources

1. Online articles and case studies on values and ethics in industrial management

2. Guest lectures from industry professionals and experts in values and ethics

3. Group discussions and debates on values and ethics topics

## 7. Course Outcomes:

| Course Outcomes | Details/Statement | Action Verb | Bloom's Level |
|---|---|---|---|
| **CO1** | Discuss Values and Ethics in industrial management. | Discuss | R,U |
| **CO2** | Analyze ethical dilemmas. | Analyze | A |
| **CO3** | Apply ethical principles | Apply | P |
| **CO4** | Develop ethical decision-making skills | Develop | C |
| **CO5** | Evaluate organizational values and culture | Evaluate | E |
| **CO6** | Apply ethics into management practices | Integrate | A |

**Course Name: STATISTICAL PROCESS CONTROL**
**Course Code: MME205C**
**(Semester II)**
**Category: Major**

**Course Broad Category: Engineering Science Courses**

1. **Course Prerequisite:**
   Statistics, Probability, and Mathematics
2. **Course Learning Objectives:**
   1. Understand the fundamental principles of Statistical Process Control (SPC).
   2. Apply SPC techniques to monitor and control processes.
   3. Analyze and interpret SPC data to make informed decisions.
   4. Implement SPC in various industries and applications.
3. **Teaching methodology and evaluation system for the course:**
   **Teaching methodology –**Lectures and Presentations, Interactive Discussions and real world problem discussion.
   **Evaluation System –**
   Attendance
   Internal Assessment (20 Marks)- Formative Continuous Assessment [Continuous Assessment 1 (10 Marks); Continuous Assessment 2 (10 Marks)]
   Mid-Term Exam (30 Marks)- Summative Assessment
   End-Semester Exam (50 Marks)- Summative Assessment.

4. **Course Content:**
   **Course Name:** STATISTICAL PROCESS CONTROL
   **Course Code:** MME205C
   **Hours per Week:** 4L:0T:0P
   **Credits:** 3

| Module | Topics | 42L | CO |
|---|---|---|---|
| 1 | Understand the fundamental principles of Statistical Process Control (SPC). Apply SPC techniques to monitor and control processes. Analyze and interpret SPC data to make informed decisions. Implement SPC in various industries and applications. | 7 | CO1 |
| 2 | Overview of SPC and its importance. History and evolution of SPC. Basic concepts: process, variation, control. Types of control charts: X-bar, R, p, c, u. Construction and interpretation of X-bar and R charts. Construction and interpretation of p, c, and u charts. | 12 | CO2, CO3, |
| 3 | Control chart selection and application. Case studies of control chart implementation. Process capability indices: Cp, Cpk, Pp, Ppk. Process capability analysis and interpretation. Relationship between process capability and control charts. Case studies of process capability analysis. | 12 | CO4, CO6, |
| 4 | Short-term and long-term process variation. Process control and capability for non-normal data. Multivariate control charts and | 11 | CO3, CO5, |

| | | | |
|---|---|---|---|
| | techniques. SPC for automated manufacturing systems. Implementing SPC in various industries and applications. Maintaining and improving SPC systems. Overcoming common obstacles to SPC implementation. Case studies of successful SPC implementation. Apply SPC techniques to a real-world process or problem. | | |

## 6. References:

**Text Book:**


1. Montgomery, D. C. (2013). Introduction to Statistical Process Control. John Wiley & Sons.

2. Grant, E. L., & Leavenworth, R. S. (1996). Statistical Quality Control. McGraw-Hill.


Software

1. Minitab

2. Excel

3. JMP

4. Python

## 7. Course Outcomes:

| Course Outcomes | Details/Statement | Action Verb | Bloom's Level |
|---|---|---|---|
| CO1 | Interpretation of Statistical Process Control | Interpret | R,U |
| CO2 | Analyze process data | Analyze | A |
| CO3 | Apply and interpret control charts | Apply | P |
| CO4 | Determine process capability | Determine | P |
| CO5 | Summarize and address special causes of variation | Summarize | E |
| CO6 | Create and maintain SPC systems | Create | C |

**Course Name: ENGINEERING SYSTEM & CONTROL**
**Course Code: MME205D**
**(Semester II)**
**Category: Major**

**Course Broad Category: Engineering Science Courses**

1. **Course Prerequisite:**
   Mathematics (Calculus, Linear Algebra), Physics
2. **Course Learning Objectives:**
   1. Understand the fundamental principles of engineering systems and control.
   2. Analyze and design control systems for various engineering applications.
   3. Apply mathematical models and techniques to control systems.
   4. Evaluate the performance and stability of control systems.
3. **Teaching methodology and evaluation system for the course:**
   **Teaching methodology –**Lectures and Presentations, Interactive Discussions and real world problem discussion.
   **Evaluation System –**
   Attendance
   Internal Assessment (20 Marks)- Formative Continuous Assessment [Continuous Assessment 1 (10 Marks); Continuous Assessment 2 (10 Marks)]
   Mid-Term Exam (30 Marks)- Summative Assessment
   End-Semester Exam (50 Marks)- Summative Assessment.

4. **Course Content:**
   **Course Name:** ENGINEERING SYSTEM & CONTROL
   **Course Code:** MME205C
   **Hours per Week:** 4L:0T:0P
   **Credits:** 3

| Module | Topics | 42L | CO |
|---|---|---|---|
| 1 | Overview of engineering systems and control. Types of control systems: open-loop, closed-loop. Control system components: sensors, actuators, and controllers. Control system applications: robotics, process control, automotive systems. | 10 | CO1,CO2 |
| 2 | Mathematical models of control systems: differential equations, transfer functions. Laplace transform and its application to control systems. Block diagrams and signal flow graphs. State-space models and their application to control systems. Time-domain analysis of control systems: transient response, steady-state response. Frequency-domain analysis of control systems: Bode plots, Nyquist plots. | 14 | CO2,CO3.CO4 |

| | | | |
|---|---|---|---|
| 3 | Stability analysis of control systems: Routh-Hurwitz criterion, root locus. Performance analysis of control systems: overshoot, settling time, steady-state error. Lead and lag compensators. PID controllers. State-space control design. Digital control systems. | 10 | CO4.CO5 |
| 4 | Nonlinear control systems. Adaptive control systems. Robust control systems. Control systems with constraints. Design and analyze a control system for a real-world application. | 8 | CO5.CO6 |

## 6. References:


1. Ogata, K. (2010). Modern Control Engineering. Prentice Hall.

2. Dorf, R. C., & Bishop, R. H. (2011). Modern Control Systems. Pearson Prentice Hall.

3. Franklin, G. F., Powell, J. D., & Emami-Naeini, A. (2010). Feedback Control of Dynamic Systems. Pearson Prentice Hall.


Software

1. MATLAB

2. Simulink

3. LabVIEW

4. Python

## 7. Course Outcomes:

| Course Outcomes | Details/Statement | Action Verb | Bloom's Level |
|---|---|---|---|
| **CO1** | Understand the fundamental principles of engineering systems and control | Understand | R,U |
| **CO2** | Analyze and model dynamic systems | Analyze | A |
| **CO3** | Design and evaluate control systems | Design | C |
| **CO4** | Apply control system design techniques | Apply | P |
| **CO5** | Analyze and interpret control system performance | Analyze | A |
| **CO6** | Formulate and simulate control systems | Formulate | C |